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(54) **COMPACT SCAN HEAD WITH MULTIPLE SCANNING MODALITIES**

KOMPAKTER ABTASTKOPF MIT MEHRFACHEN ABTASTMODALITAETEN

TETE DE LECTURE COMPACTE POSSEDANT DIVERSES FONCTIONS DE BALAYAGE

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Description

Technical Field

[0001] This invention relates to moving head optical scanners for stimulation of a target sample and for reading the return signal radiation from the target.

Background Art

[0002] Optical scanners for stimulation of target samples and for detection of the resulting signal radiation emerging from the samples are used in many experimental formats. Optical scanners having movable scan heads are particularly useful for variable field size. However, many existing scanners, including those with movable scan heads, are limited with respect to scan speed because of their numerous components and the high mass of their optical assemblies. It is desirable to increase scan speed without compromising resolution in order to scan many samples in a short period of time.

[0003] A wide variety of scan formats is necessary for many research and diagnostic applications. For example, emerging formats include the scanning of large gels containing fluorescent labels, and the scanning of miniature chips or membranes supporting minute samples. In addition to the variability desired with respect to scan formats, versatility with respect to types of optical analysis is extremely important. Analysis of samples based on storage phosphor emission, fluorescent, reflected, and transmitted light may be necessary. Space and cost considerations dictate the use of instruments allowing analysis in more than one of these modalities.

[0004] Because these various optical scanning modalities generally require exciting or stimulating light of a unique wavelength and collection and detection optics capable of separating the various types of returned signals from the target sample, merging many scanning modalities into one optical scanner has been difficult in the past. Providing multiple simultaneous incident wavelengths and subsequently descanning and detecting the coincident sample emission generally results in complex and expensive instruments and difficult analysis. For example, see U.S. Pat. No. 5,304,810 to Amos.

[0005] In WO 95/04263, representing the closest prior art, there is disclosed a single light source, a single common light path, a single detector, and a filter wheel to distinguish the different available channels.

[0006] In US 5386112, there is a single light source, common portions of the optical path, a single detector and a beamsplitter, half-wave plate and analyzer to distinguish transmitted and reflected channels.

[0007] Furthermore, in EP 0418928, there is a single light source, a common optical path until beamsplitters leading to three detectors for red, green and blue channels.

[0008] In US 5266803, there is disclosed a single light source, a single detector, and only one channel.

[0009] It is therefore an object of the present invention to provide a compact, versatile optical scanner of simple, lightweight, and low cost design for rapid scanning of target samples according to any of a multiple of scanning modalities.

Disclosure of the Invention

[0010] The invention is defined in claim 1. Particular embodiments of the invention are set out in the dependent claims. In particular, the above object has been achieved with a movable compact scan head having multiple scanning modalities. The scan head supports two or more optical systems within a small space. The optical systems may or may not be coincident, each one designed for a specific stimulation and detection modality. Possible modalities include stimulation and detection of storage phosphor emission, fluorescence including chemi-fluorescence, reflection, and transmission. One optical system may include a laser diode or other compact lightweight laser device light source, and have a first channel for storage phosphor emission and a second channel for fluorescence. A separate optical system may have a light emitting diode (LED) light source and a third channel for reflection signals or fluorescence emission by a sample stimulated at a wavelength other than that of the second channel. Multiple combinations of light sources of various properties may be employed.

[0011] As used here, "laser diode" includes other compact, lightweight laser devices. The term "remotely positioned" means the element is not situated on the scan head. The term "wavelength" may signify a wavelength band, especially with regard to sample emission. The term "emission" includes storage phosphor, fluorescent, reflected, and transmitted signals from the sample.

[0012] Typically, a first side of the scan head supports a laser diode light source for stimulation of a sample at a first wavelength. Light emitted from the sample at both lower and higher wavelengths than the stimulating wavelength may be collected. This is possible through an interference-type spectral beam splitter which passes the laser diode wavelength and which reflects light below and above this wavelength toward the detection optics. For example, a red laser diode provides an excitation wavelength of approximately 635 nm. Storage phosphor emission resulting from this stimulation is generally at 390 nm and fluorescence emission is generally at 650 nm or more. Thus, these two types of signals from the sample or samples will be reflected by the beam splitter. An adjustable filter changer assembly providing the filters needed for isolating the signals of interest may be used in the detection path on this first side of the scan head. At least one filter is generally dedicated to passing light of a lower wavelength than the stimulating wavelength and at least one filter is generally dedicated to passing light of a higher wavelength than the stimulating wavelength. A detector, mounted on the scan head directly, or in a remote location and connected to the scan head via an optical fiber, is used for collection of the filtered signals.

[0013] A second side of the scan head may support an LED point scanning system, as disclosed in commonly assigned U.S. patent application Serial No. 08/438,416. The LED light source on this second side of the scan head provides a different stimulating wavelength than does the first side of the compact scan head of the present invention. With this second wavelength, fluorescence and reflective analysis of the target samples may be performed. The LED point scanning is preferably accomplished through the use of a spatial filter with a pinhole aperture, or an optical fiber, in the stimulating light path. The stimulating beam is focused into the pinhole or the fiber. This restriction of the diameter of the stimulating beam provides an apparent point light source and allows for rapid, high resolution scanning.

[0014] A support wall preferably separates the first side of the scan head from the second side and provides the physical support for the various elements. Thus, the two sides do not share any optical elements. Within the first side, however, many optical elements are common to both the storage phosphor emission and fluorescence modalities, i.e. the first and second data channels. For example, the laser diode light source and the beam splitter are common to both modalities. The third data channel of the second side of the scan head is physically and optically separate from the first and second data channels.

[0015] Although three data channels are particularly advantageous, the compact, movable scan head of the present invention may comprise any two of the above channels. Furthermore, additional channels providing additional stimulating beams may be incorporated into the scan head.

[0016] By incorporating the various elements into a compact scan head and moving the scan head, as opposed to moving a scanning mechanism within the optical system, a lightweight, high speed, and extremely versatile scanning' system is achieved. The present invention may be used for analysis of storage phosphor screens and samples within membranes, electrophoretic gels, and microtiter sample plates, among others.

Brief Description of the Drawings

[0017]

Fig. 1 is a plan view of a first side of the scan head of the present invention, with a laser diode light source.

Fig. 2 is a plan view of a second side of the scan head of the present invention, with an LED light source.

Fig. 3 is a perspective view of the optical elements of Fig. 1 and the support wall of the scan head.

Fig. 4 is a perspective view of the optical elements of Fig. 2 and a second side of the support wall of the scan head.

Fig. 5 is a plan view of a portion of Fig. 1, showing an alternate embodiment of the detector placement on the first side of the scan head.

Fig. 6 is a plan view of a portion of Fig. 2, showing an alternate embodiment of the detector placement on the second side of the scan head.

Fig. 7 is a plan view of an alternate embodiment of the stimulating beam restriction of the second side of the scan head.

Fig. 8 is a portion of a plan view of an alternate embodiment of the scan head, showing multiple stimulating beams on a single side of the scan head.

Fig. 9 is a plan view of an alternate embodiment of the scan head, showing optical fiber delivery of a stimulating beam to the scan head from a remotely positioned light source.

Fig. 10 is a plan view of a data collection and display apparatus for use with the scan head of the present invention.

Best Mode for Carrying Out the Invention

[0018] With reference to Fig. 1, laser diode 14 is shown providing a beam of a first wavelength λ_{st1}. This exciting or stimulating beam is preferably passed through collimating lens 16 and then passes through beam splitter 18. After passing through beam splitter 18, the stimulating beam of wavelength λ_{st1} passes through objective 22 and is focused onto a spot of sample 20 to cause signal radiation to be returned from the sample. The signal radiation emitted from sample 20 is gathered by objective 22, which has a high numerical aperture, into an emission beam and is directed back toward beam splitter 18.

[0019] Beam splitter 18 is an interference-type spectral beam splitter designed to pass light of a specific wavelength, for example the laser diode wavelength λ_{st1}, and to reflect light of a lower or higher wavelength than λ_{st1}. As stated earlier, "wavelength" includes wavelength bands, as typical emission for certain applications occur over ranges rather than as discrete wavelengths. In Fig. 1, the beam representing the light or signal radiation emitted by the sample has a wavelength of λ_{em} and is reflected by beam splitter 18 toward a detection path.

[0020] Since the wavelength λ_{em} may be of a wavelength lower or higher than the stimulating wavelength λ_{st1}, a filter system is preferred in the detection path to isolate the desired sample emission for detection. Filter changer assembly 24 is shown in the detection path of Fig. 1, as an example of a filter system useful for isolation of emission. Filter changer assembly 24 contains three filters 26a-c. At least one of these filters isolates a beam of a wavelength λ_{em}, particularly $\lambda_{em/p}$, which is lower or shorter than λ_{st1}, and at least one of these filters isolates a beam of wavelength λ_{em}, particularly $\lambda_{em/f}$, which is higher or longer than wavelength λ_{st1}. The filter changer assembly may be moved by a shifting means 70, as shown by arrow A. This allows the correct filter to be placed in the path of the emission beam. Fig. 3 shows a means for shifting each of the filters within a slot 68 in support wall 60 of the scan head. The means for shifting 70 may be an actuator driven by a motor. Alternatively, the filter changer assembly 24 may have a plurality of filters in some other configuration, e.g. the filters may be mounted on a wheel and preferably rotated by a motor.

[0021] The filtered emission are then passed through focusing lens 28 and onto the detector 30. The detector may be mounted on the scan head, as shown by detector 30 of Fig. 1, or it may be positioned remotely, as shown in Fig. 5. In this latter case, the focusing lens 28 focuses the emission beam into an optical fiber 58 which transmits the emission beam to the remotely positioned detector 56.

[0022] The laser diode or other compact laser device may be of any of a variety of colors and wavelengths. For example, infrared and red laser diodes are available. The laser may also be a compact, solid state, frequency-doubled diode or frequency-doubled diode pumped YAG laser. The use of a red laser diode is particularly useful, as it provides a stimulating beam having a wavelength λ_{st1} of approximately 635 nm. Stimulation of the sample with light of this wavelength may cause fluorescence emission of a higher wavelength, e.g. 650 to 700 nm, and emission from a storage phosphor screen at a lower wavelength, e.g. approximately 390 nm. Thus, beam splitter 18 passes light of 635 nm but reflects both lower and higher numbers or shorter and longer wavelengths. "Approximately," as used here, indicates a value within $\pm$ 10% of the given value.

[0023] The first side 11 of scan head 10 thus shows a first data channel, capable of reading storage phosphor screens by stimulating with wavelength λ_{st1} and detecting emission through use of the appropriate filter in the detection path, and a second data channel, capable of reading fluorescent emission by stimulating with wavelength λ_{st1} and detecting emission through use of the appropriate filter in the detection path. The first channel detects emission of wavelength $\lambda_{em/p}$ where $\lambda_{em/p} < \lambda_{st1}$. The second channel detects emission of wavelength $\lambda_{em/f}$ where $\lambda_{em/f} > \lambda_{st1}$. Collection and detection of transmitted and reflected signals resulting from laser diode stimulation may also be achieved, as through transmission collection and detection device 78, shown in Fig. 7, or through other well-known detection paths.

[0024] Compact scan head 10 may be moved across a sample in two dimensions, as seen by arrows X and Y, which represent perpendicular axes. Alternatively, scan head 10 may move in a first direction relative to sample 20 and the sample may be moved in a perpendicular direction as by a motorized stage, or the scanning may occur according to some other scan pattern. The scan head may be moved by sliding it along a rail with a belt and pulley, lead screw, or other actuating means. Fig. 4 shows a means for moving 76 the scan head. Scanning is preferably accomplished in a point-by-point imaging manner wherein a plurality of spots of the sample are sequentially subjected to stimulation and detection of resulting emission.

[0025] Fig. 2 shows a second side 12 of scan head 10 of the present invention. The second side supports an LED point scanning system, such as that disclosed in commonly assigned patent application U.S. Serial No. 08/438,416. As seen in Fig. 2, LED 32 provides a stimulating beam of a second wavelength λ_{st2} which is focused by focusing lens 34 into the pinhole aperture 38 of spatial filter 36. This effectively restricts the diameter of the stimulating beam and defines the necessary resolution for stimulation. The stimulating beam of wavelength λ_{st2} thus functions as a point light source. This is an important advantage as an LED is an incoherent light source and restriction of this nature allows for high resolution scanning. Alternatively, an optical fiber may provide the necessary restriction of the stimulation beam.

[0026] Fig. 7 shows this alternate embodiment wherein an optical fiber 66 replaces spatial filter 36; focusing lens 34 then serves to focus the stimulating beam of wavelength λ_{st2} into optical fiber 66. The focal points of lenses 34 and 42 are also spaced apart with fiber 66 between them. Fig. 7 also shows a transmitted light collector and detector 78. This transmission system 78, although shown in the Fig. 7 embodiment for clarity, may be used with any of the light sources on either side of the scan head.

[0027] The restricted stimulating beam is collected by collimating lens 42 and passed through a filter 44 and then directed onto the sample. Fig. 2 shows a beam splitter 46 reflecting the stimulating beam and directing it toward objective 40 where it is focused onto a spot of sample 20. Light emitted or returned from the sample, for example fluorescent or reflective signal radiation, is then collected by objective 40 and passes through beam splitter 46 to be directed toward the detection path of this third data channel. An appropriate beam splitter for fluorescent or reflective emission may be used. The emission returned from the sample are reflected by mirror 48 in Fig. 2 and directed through a second filter 52 and then through a second focusing lens 54. Focusing lens 54 serves to focus the beam onto detector 50. As in Fig. 1, the detector may be mounted on the scan head 10 or it may be positioned remotely and connected to the scan head via an optical fiber. Fig. 6 shows this detector placement alternative, with focusing lens 54 serving to focus the returned emission into optical fiber 64 for transmission to detector 62, which is off scan head 10.

[0028] As disclosed in U.S. Serial No. 08/438,416, other variations of the LED point scanning system are possible on this second side of the compact scan head of the present invention. The LED provides an inexpensive alternative to the laser diode and is particularly useful for certain specified wavelengths. For example, a blue LED providing a stimulation beam of a wavelength centered at approximately 450 nm may advantageously be used to stimulate samples for chemi-fluorescence applications. Green, yellow, orange, red, and infrared LEDs are also available.

[0029] Figs. 3 and 4 illustrate the described two sides of the scan head in perspective. Figs. 3 and 4 depict support wall 60, which is a preferred support within scan head 10, and serves as the support to which the optical elements of all configurations are mounted.

[0030] The compact scan head of the present invention contains multiple scanning modalities which may or may not be coincident. For example, in Figs. 3 and 4, two objectives 22 and 40 are visible. Objective 22 is part of the laser diode optical system on the first side 11 of the scan head, and objective 40 is part of the LED point scanning system of the second side 12 of the scan head. Support wall 60 completely separates all of the optical elements of the two sides of the scan head and, thus, the laser diode and the LED optical systems are separate. The first and second data channels share a laser diode, a collimating lens, beam splitter, and a detector, among other optical elements, however, and so, these modalities are at least partially coincident. The sample may be mounted relative to the scan head so that scanning by either side, and thus either optical configuration, or according to any of the three channels of the scan head, is possible. This is facilitated by the movable scan head and its preferred two-dimensional translation relative to the sample.

[0031] Fig. 8 shows an alternate embodiment of the scan head, with multiple stimulating beams. On the first side 11 of the scan head, a second laser diode 15 is shown. Laser diode 15 provides a stimulating beam which may be included in the stimulation optical path of the first side of the scan head via beam splitter 17. This second source may provide a different stimulating wavelength than the first source. Alternatively, the second source may provide a different optical property than the first source. For example, the two sources may provide pulsed and continuous wave beams, or polarized and nonpolarized beams. In this manner, a plurality of light sources may be used on the first side of the scan head. Stimulation preferably occurs in a sequential manner. The second side of the scan head may also have more than one light source. A second LED with an affiliated beam restriction means may be inserted into the optical path of the second side of the scan head, for example. These multiple sources on the second side may also provide unique wavelengths or other properties. The various channels on opposite sides of the scan head may also utilize beams of different optical properties, in general, rather than simply utilizing different wavelengths for stimulation.

[0032] With reference to Fig. 9, optical fiber delivery via optical fiber 67, from remotely positioned LED 33 to the scan head is shown. LED 33 provides a stimulating beam which is focused by lens 35 into fiber 67. Fiber 67, in this instance, serves as both a delivery means and a restriction means. The restricted beam is received by lens 42, as before, and directed toward the sample. The laser diode stimulating beam of the first side may also be delivered from a remotely positioned source to the scan head through the use of an optical fiber.

[0033] Although separate on-head detectors 30 and 50, seen in Figs. 1-2, and off-head detectors 56 and 62, seen in Figs. 5-6, are shown and described for the laser diode and LED optical systems, a combined detector may be used for the various channels and systems. A single detector may be particularly convenient when positioned remotely and connected to relevant locations within the scan head 10 by optical fibers. An array-type detector may also be used for the various channels. Additionally, a spatial filter may be added to the detection path of the laser diode or LED optical systems, limiting the signals reaching the detector and, in certain cases, creating confocal systems.

[0034] Each of the three channels, 81, 82, and 83 of Fig. 10, provides data regarding emission within the channel. These data are collected from the various detectors by a data analysis or processing means 72, such as a computer, and displayed, such as on a multi-channel data display 74, or saved in a memory for future analysis. The video monitor, or other display, may display data from any or all of the three channels. Multi-channel displays are known in the art. The data analysis means may be programmed to operate the channels sequentially on the sample or to direct operation of the appropriate channel according to the nature of the sample. For example, the particular dimensions of a storage phosphor screen or of a microtiter plate may cause first or third data channel stimulation and detection of emission to occur, the fitting of the sample holder onto the stage triggering the appropriate channel. Simultaneous reading of a sample according to more than one channel may also occur.

[0035] The compactness of the scan head allows for high speed scanning and its optical systems allow for high resolution scanning. In addition, the scan head of the present invention provides versatility with regard to sample formats and types of optical analysis, thus contributing to reduced laboratory operating costs.

Claims

1. A movable scan head optically coupled to stimulation and detection means (14, 32, 30, 50) for a plurality of the group comprising phosphorescence, fluorescence, reflection, and transmission for analyzing a sample, the scan head (10) comprising:

   (a) first channel means (81) for stimulating the sample (20) with a beam of a first wavelength and detecting resultant storage phosphor emission from the sample,

(b) second channel means (82) for stimulating the sample (20) with a beam of the first wavelength and detecting resultant fluorescent emission from the sample, wherein the first channel means (81) and second channel means (82) have common portions of their respective optical paths, and filter means (24) for distinguishing emissions from the sample corresponding to the first and second channel means,

(c) third channel means (83) for stimulating the sample (20) with a beam of a second wavelength and detecting resultant second wavelength-stimulated emission from the sample, and

(d) means (76) for moving the scan head (10) relative to the sample (20) in a scan pattern,

characterized in that

the first and second channel means (81, 82) are positioned on a first side (11) of a support wall (60) of the scan head (10) and the third channel means (83) is positioned on the opposite side (12) of said support wall (60).

2. The scan head of claim 1 further comprising:

means (74) for displaying the information regarding emission from any of the first, second and third channel means.

3. The scan head of claim 1 wherein the first and second channel means (81, 82) include a compact, lightweight laser device (14).

4. The scan head of claim 3 wherein the first and second channel means (81, 82) include a laser diode (14).

5. The scan head of claim 1 wherein the first and second channel means (81, 82) include a beam splitter (18) for passing the first wavelength stimulating beam and for reflecting emission received from the sample which is of a wavelength lower than or higher than the first wavelength.

6. The scan head of claim 5 wherein the first and second channel means (81, 82) include a filter changer assembly (24) disposed to receive emission reflected by the beam splitter (18), the filter changer assembly (24) having at least one filter (26a; 26b; 26c) for passing emission received from the sample (20) which is of a wavelength lower than the first wavelength and at least one filter (26a; 26b; 26c) for passing emission received from the sample (20) which is of a wavelength higher than the first wavelength, and having means (70) for shifting each of the filters into the first and second channel means.

7. The scan head of claim 1 wherein the third channel means (83) includes an LED (32).

8. The scan head of claim 1 wherein the third channel means (83) includes a spatial filter (36) having a pinhole aperture (38) and a means (34) for focusing the second wavelength stimulating beam into the pinhole aperture (38) for restriction of the diameter of the second wavelength stimulating beam to a point light source for stimulation of the sample (20).

9. The scan head of claim 1 wherein the third channel means (83) includes an optical fiber (66; 67) and a means (34; 35) for focusing the second wavelength stimulating beam into the optical fiber for restriction of the diameter of the second wavelength stimulating beam to a point light source for stimulation of the sample (20).

10. The scan head of claim 1 wherein the detection means (72) directs operation of the first, second and third channel means sequentially on the sample (20).

11. The scan head of claim 1 further comprising:

a fourth channel means for stimulating the sample (20) with a beam of a third wavelength and detecting resultant third wavelength stimulated emission from the sample (20),

wherein the detection means (72) for collecting information regarding emission from the first, second and third channel means collects information regarding emission from the fourth channel means.

12. The scan head of claim 1 further comprising:

a fifth channel means for stimulating light with a beam of a fourth wavelength and detecting resultant fourth wavelength stimulated emission from the sample (20),

wherein the detection means (72) for collecting information regarding emission from the first, second and third channel means collects information regarding emission from the fifth channel means.

Patentansprüche

1. Beweglicher Abtastkopf, der optisch mit einem Anregungs- und Erfassungsmittel (14, 32, 30, 50) für eine Vielzahl der Gruppe, die Phosphoreszenz, Fluoreszenz, Reflexion und Durchlass umfasst, gekoppelt ist, um eine Probe zu analysieren, wobei der Abtastkopf (10) umfasst:

(a) ein erstes Kanalmittel (81) zum Anregen der Probe (20) mit einem Strahl mit einer ersten Wellenlänge und zum Erfassen einer resultierenden Speicherleuchtstoffemission von der Probe,
(b) ein zweites Kanalmittel (82) zum Anregen der Probe (20) mit einem Strahl mit der ersten Wellenlänge und zum Erfassen einer resultierenden Fluoreszenzemission von der Probe, wobei das erste Kanalmittel (81) und das zweite Kanalmittel (82) gemeinsame Teile ihrer jeweiligen Strahlengänge aufweisen, und einem Filtermittel (24) zum Unterscheiden der Emissionen von der Probe entsprechend dem ersten und dem zweiten Kanalmittel,
(c) ein drittes Kanalmittel (83) zum Anregen der Probe (20) mit einem Strahl mit einer zweiten Wellenlänge und zum Erfassen einer resultierenden mit der zweiten Wellenlänge angeregten Emission von der Probe, und
(d) ein Mittel (76) zum Bewegen des Abtastkopfs (10) relativ zur Probe (20) in einem Abtastmuster,

dadurch gekennzeichnet, dass

das erste und das zweite Kanalmittel (81, 82) auf einer ersten Seite (11) einer Trägerwand (60) des Abtastkopfs (10) angeordnet sind und das dritte Kanalmittel (83) auf der entgegengesetzten Seite (12) der Trägerwand (60) angeordnet ist.

2. Abtastkopf nach Anspruch 1, welcher ferner umfasst:

ein Mittel (74) zum Anzeigen der Information hinsichtlich der Emission von irgendeinem des ersten, des zweiten und des dritten Kanalmittels.

3. Abtastkopf nach Anspruch 1, wobei das erste und das zweite Kanalmittel (81, 82) eine kompakte, leichtgewichtige Laservorrichtung (14) umfassen.

4. Abtastkopf nach Anspruch 3, wobei das erste und das zweite Kanalmittel (81, 82) eine Laserdiode (14) umfassen.

5. Abtastkopf nach Anspruch 1, wobei das erste und das zweite Kanalmittel (81, 82) einen Strahlteiler (18) zum Durchlassen des Anregungsstrahls mit der ersten Wellenlänge und zum Reflektieren der von der Probe empfangenen Emission, die eine niedrigere oder höhere Wellenlänge als die erste Wellenlänge aufweist, umfassen.

6. Abtastkopf nach Anspruch 5, wobei das erste und das zweite Kanalmittel (81, 82) eine Filterwechselanordnung (24) umfassen, die zum Empfangen der vom Strahlteiler (18) reflektierten Emission angeordnet ist, wobei die Filterwechselanordnung (24) mindestens ein Filter (26a; 26b; 26c) zum Durchlassen der von der Probe (20) empfangenen Emission, die eine niedrigere Wellenlänge als die erste Wellenlänge aufweist, und mindestens ein Filter (26a; 26b; 26c) zum Durchlassen der von der Probe (20) empfangenen Emission, die eine höhere Wellenlänge als die erste Wellenlänge aufweist, aufweist und ein Mittel (70) zum Verschieben von jedem der Filter in das erste und das zweite Kanalmittel aufweist.

7. Abtastkopf nach Anspruch 1, wobei das dritte Kanalmittel (83) eine LED (32) umfasst.

8. Abtastkopf nach Anspruch 1, wobei das dritte Kanalmittel (83) ein räumliches Filter (36) mit einer Lochblendenöffnung (38) und ein Mittel (34) zum Fokussieren des Anregungsstrahls mit der zweiten Wellenlänge in die Lochblendenöffnung (38) zur Einschränkung des Durchmessers des Anregungsstrahls mit der zweiten Wellenlänge auf eine Punktlichtquelle zur Anregung der Probe (20) umfasst.

9. Abtastkopf nach Anspruch 1, wobei das dritte Kanalmittel (83) eine optische Faser (66; 67) und ein Mittel (34; 35) zum Fokussieren des Anregungsstrahls mit der zweiten Wellenlänge in die optische Faser zur Einschränkung des Durchmessers des Anregungsstrahls mit der zweiten Wellenlänge auf eine Punktlichtquelle zur Anregung der Probe (20) umfasst.

10. Abtastkopf nach Anspruch 1, wobei das Erfassungsmittel (72) die Funktion des ersten, des zweiten und des dritten Kanalmittels nacheinander auf die Probe (20) richtet.

11. Abtastkopf nach Anspruch 1, welcher ferner umfasst:

ein viertes Kanalmittel zum Anregen der Probe (20) mit einem Strahl mit einer dritten Wellenlänge und zum Erfassen der resultierenden mit der dritten Wellenlänge angeregten Emission von der Probe (20),

wobei das Erfassungsmittel (72) zum Sammeln einer Information hinsichtlich der Emission vom ersten, vom zweiten und vom dritten Kanalmittel eine Information hinsichtlich der Emission vom vierten Kanalmittel sammelt.

12. Abtastkopf nach Anspruch 1, welcher ferner umfasst:

ein fünftes Kanalmittel für Anregungslicht mit einem Strahl mit einer vierten Wellenlänge und zum Erfassen einer resultierenden mit der vierten Wellenlänge angeregten Emission von der Probe (20),

wobei das Erfassungsmittel (72) zum Sammeln einer Information hinsichtlich der Emission vom ersten, vom zweiten und vom dritten Kanalmittel eine Information hinsichtlich der Emission vom fünften Kanalmittel sammelt.

Revendications

1. Tête de balayage couplée optiquement à un moyen de stimulation et de détection (14, 32, 30, 50) pour une pluralité d'éléments parmi le groupe comprenant la phosphorescence, la fluorescence, la réflexion et la transmission en vue d'analyser un échantillon, la tête de balayage (10) comprenant :

   (a) un premier moyen de canal (81) destiné à stimuler l'échantillon (20) avec un faisceau à une première longueur d'onde et destiné à détecter l'émission résultante d'un luminophore de mémorisation de l'échantillon,
   (b) un second moyen de canal (82) destiné à stimuler l'échantillon (20) avec un faisceau à la première longueur d'onde et à détecter l'émission fluorescente résultante de l'échantillon, dans lequel le premier moyen de canal (81) et le second moyen de canal (82) ont des parties communes de leurs trajets optiques respectifs, et un moyen de filtre (24) destiné à distinguer des émissions de l'échantillon correspondant aux premier et second moyens de canaux,
   (c) un troisième moyen de canal (83) destiné à stimuler l'échantillon (20) avec un faisceau à une seconde longueur d'onde et à détecter l'émission résultante stimulée par la seconde longueur d'onde de l'échantillon, et
   (d) un moyen (76) destiné à déplacer la tête de balayage (10) par rapport à l'échantillon (20) suivant une séquence de balayage,

   caractérisée en ce que les premier et second moyens de canaux (81, 82) sont positionnés sur une première face (11) d'une paroi de support (60) de la tête de balayage (10) et le troisième moyen de canal (83) est positionné sur la face opposée (12) de ladite paroi de support (60).

2. Tête de balayage selon la revendication 1, comprenant en outre :

   un moyen (74) destiné à afficher les informations concernant l'émission de l'un quelconque des premier, second et troisième moyens de canaux.

3. Tête de balayage selon la revendication 1, dans laquelle les premier et second moyens de canaux (81, 82) comprennent un dispositif à laser (14) compact, léger.

4. Tête de balayage selon la revendication 3, dans laquelle les premier et second moyens de canaux (81, 82) comprennent une diode laser (14).

5. Tête de balayage selon la revendication 1, dans laquelle les premier et second moyens de canaux (81, 82) comprennent un séparateur de faisceau (18) destiné à laisser passer un faisceau de stimulation à la première longueur d'onde, et à réfléchir une émission reçue depuis l'échantillon qui est d'une longueur d'onde inférieure ou supérieure à la première longueur d'onde.

6. Tête de balayage selon la revendication 5, dans laquelle les premier et second moyens de canaux (81, 82) comprennent un ensemble de changeur de filtres (24) disposé pour recevoir une émission réfléchie par le séparateur de faisceau (18), l'ensemble de changeur de filtres (24) comportant au moins un filtre (26a ; 26b ; 26c) destiné à laisser passer l'émission reçue de l'échantillon (20) qui est d'une longueur d'onde inférieure à la première longueur d'onde et au moins un filtre (26a ; 26b ; 26c) destiné à laisser passer une émission reçue de l'échantillon qui est d'une longueur d'onde supérieure à la première longueur d'onde, et comportant un moyen (70) destiné à décaler chacun des filtres dans les premier et second moyens de canaux.

7. Tête de balayage selon la revendication 1, dans laquelle le troisième moyen de canal (83) comprend une diode électroluminescente (LED) (32).

8. Tête de balayage selon la revendication 1, dans laquelle le troisième moyen de canal (83) comprend un filtre dans l'espace (36) ayant une ouverture en trou d'épingle (38) et un moyen (34) destiné à focaliser le faisceau de stimulation à la seconde longueur d'onde dans l'ouverture en trou d'épingle (38) en vue d'une restriction du diamètre du faisceau de stimulation à la seconde longueur d'onde à une source lumineuse ponctuelle pour la stimulation de l'échantillon (20).

9. Tête de balayage selon la revendication 1, dans laquelle le troisième moyen de canal (83) comprend une fibre optique (66, 67) et un moyen (34, 35) destiné à focaliser le faisceau de stimulation de seconde longueur d'onde dans la fibre optique en vue d'une restriction du diamètre du faisceau de stimu-

lation de seconde longueur d'onde à une source lumineuse ponctuelle pour la stimulation de l'échantillon (20).

10. Tête de balayage selon la revendication 1, dans laquelle le moyen de détection (72) dirige le fonctionnement des premier, second et troisième moyens de canaux séquentiellement sur l'échantillon (20).

11. Tête de balayage selon la revendication 1, comprenant en outre :

un quatrième moyen de canal destiné à stimuler l'échantillon (20) avec un faisceau d'une troisième longueur d'onde et destiné à détecter l'émission stimulée résultante à la troisième longueur d'onde provenant de l'échantillon (20),

dans laquelle le moyen de détection (72) destiné à recueillir des informations concernant l'émission depuis les premier, second et troisième moyens de canaux recueille des informations concernant l'émission depuis le quatrième moyen de canal.

12. Tête de balayage selon la revendication 1, comprenant en outre :

un cinquième moyen de canal destiné à stimuler de la lumière avec un faisceau d'une quatrième longueur d'onde, et destiné à détecter l'émission stimulée résultante à la quatrième longueur d'onde provenant de l'échantillon (20),

dans laquelle le moyen de détection (72) destiné à recueillir des informations concernant l'émission depuis les premier, second et troisième moyens de canaux recueille des informations concernant l'émission du cinquième moyen de canal.

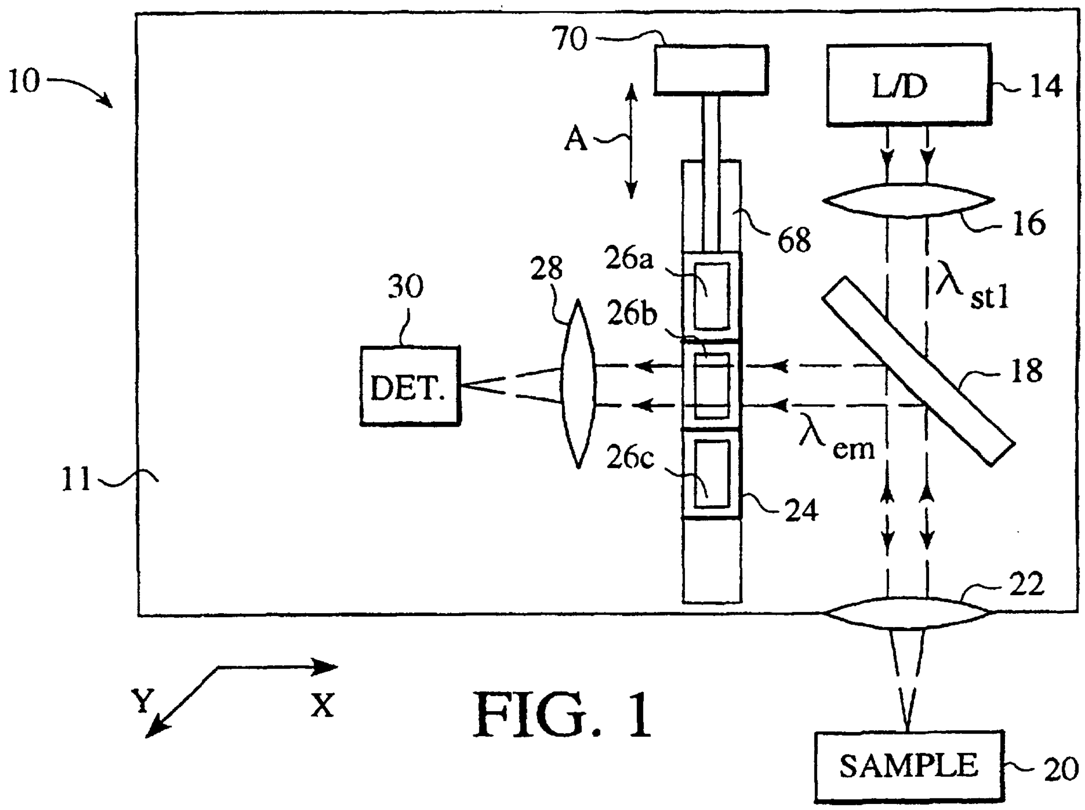
10
70
L/D
14
A
16
68
26a
λst1
30
28
26b
18
DET.
λem
26c
11
24
22
Y
X
SAMPLE
20

FIG. 1

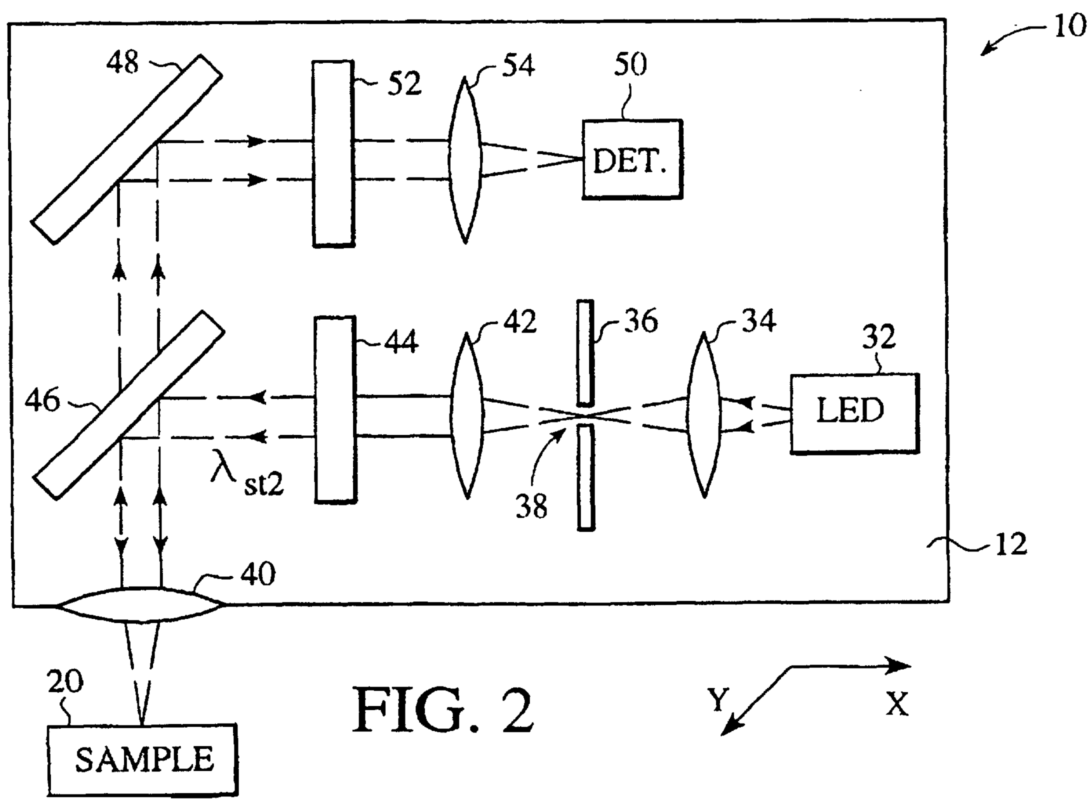
10
48
52
54
50
DET.
44
42
36
34
32
46
LED
λst2
38
12
40
20
SAMPLE
Y
X

FIG. 2

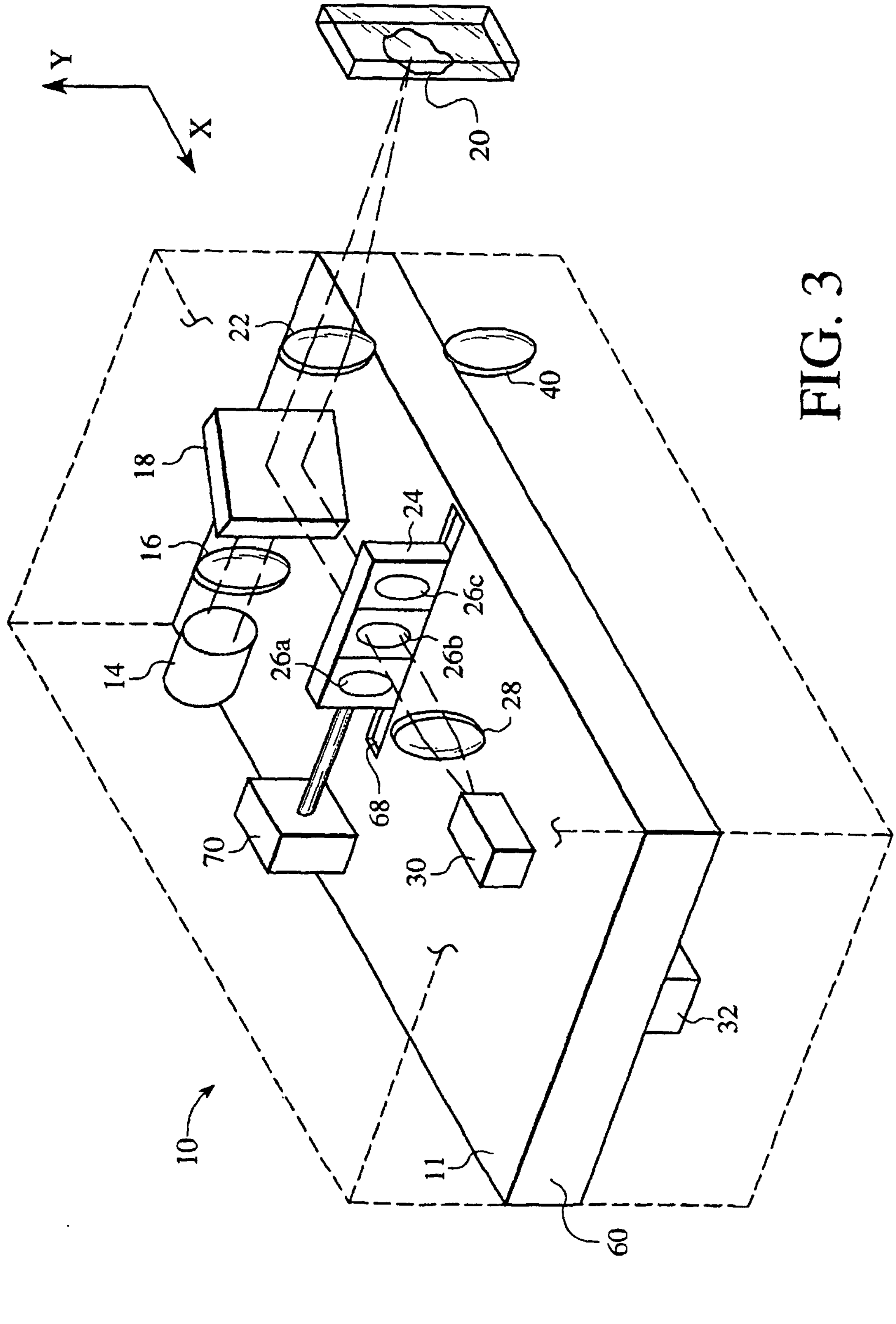

FIG. 3

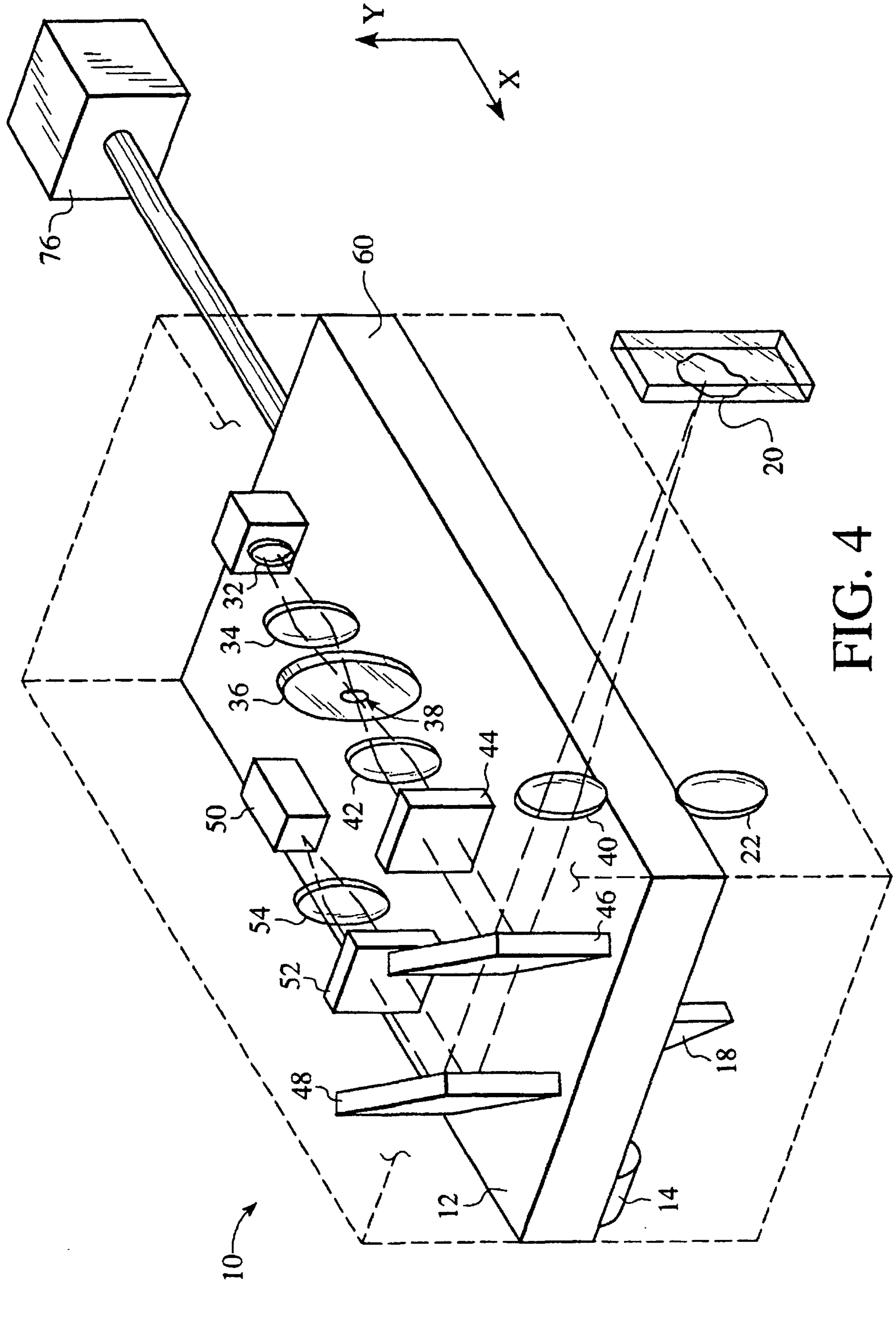

FIG. 4

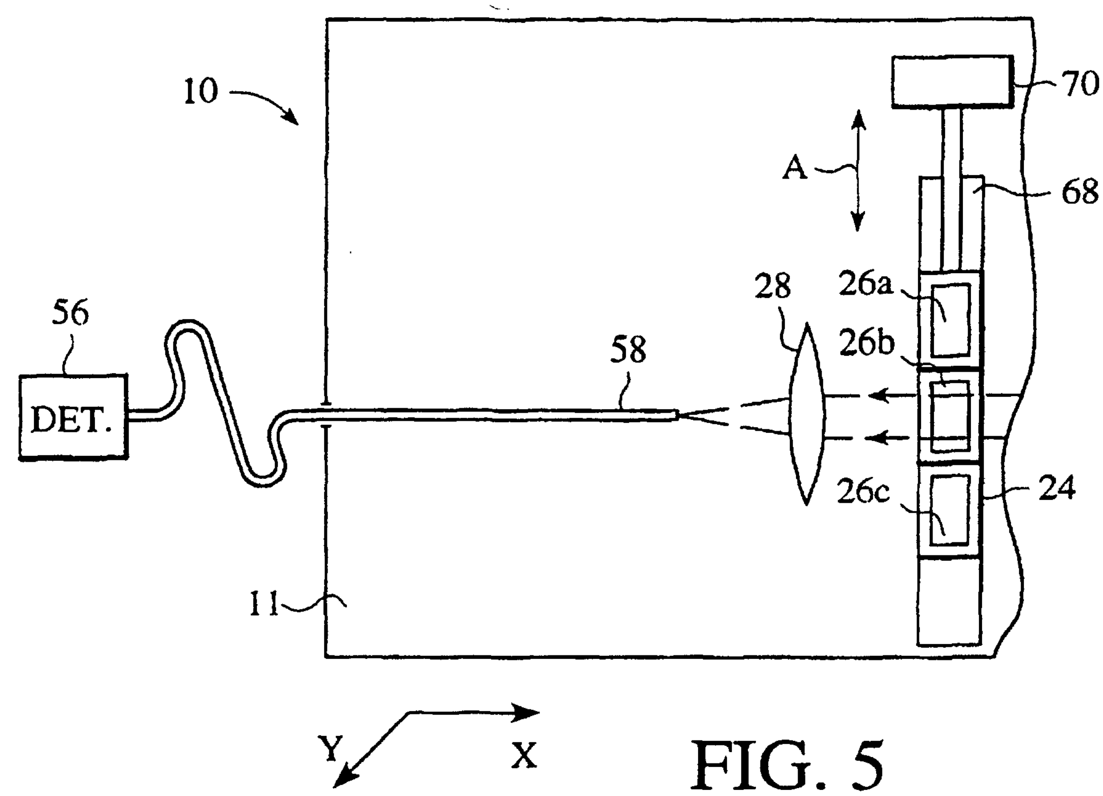
10
70
A
68
28
26a
56
26b
58
DET.
24
26c
11
Y
X

FIG. 5

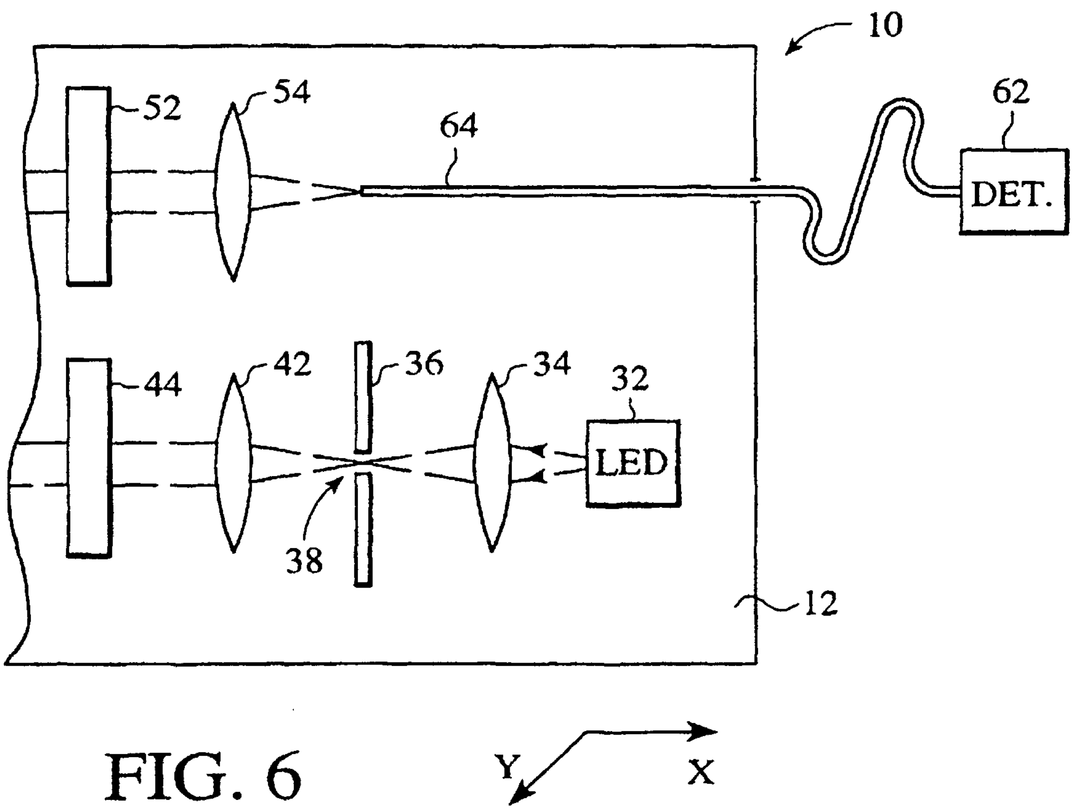
10
52
54
62
64
DET.
44
42
36
34
32
LED
38
12
Y
X

FIG. 6

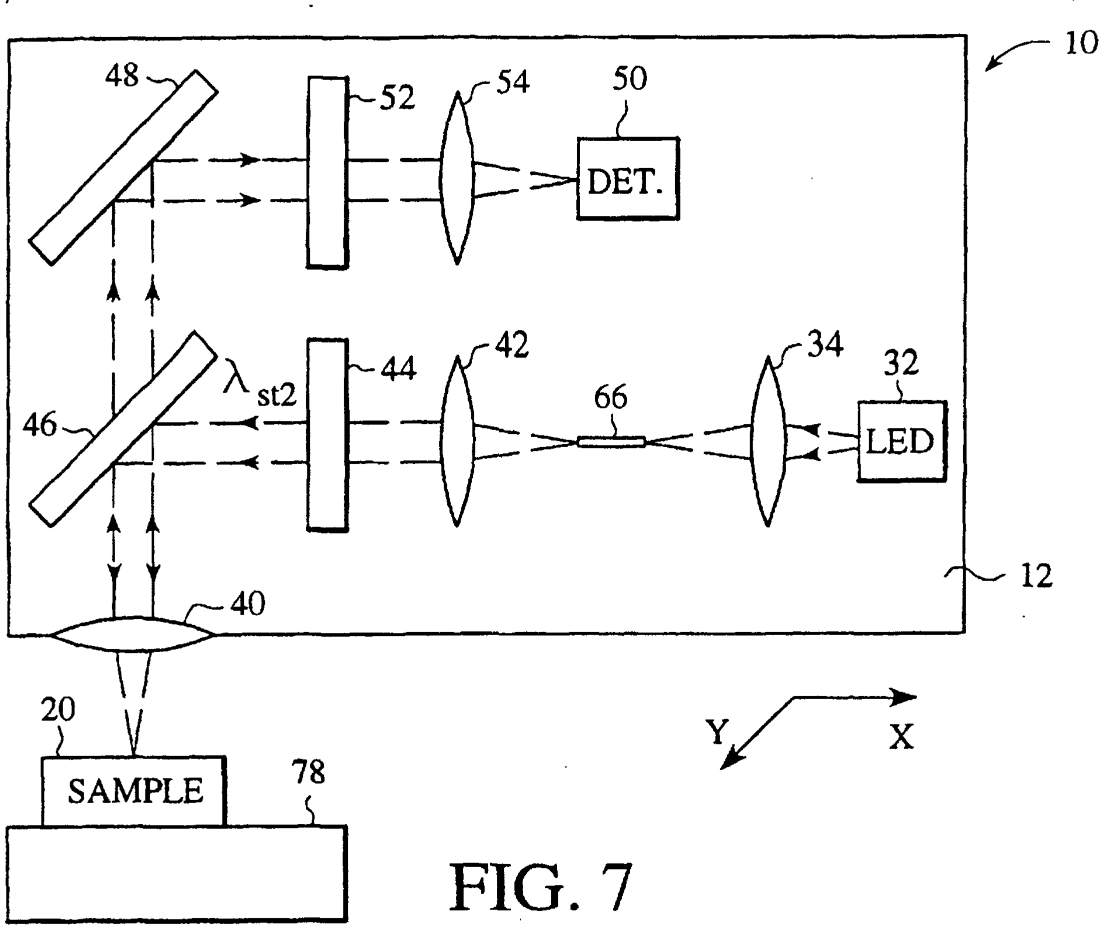
10
48
52
54
50
DET.
46
λ_{st2}
44
42
66
34
32
LED
12
40
20
SAMPLE
78
Y
X

FIG. 7

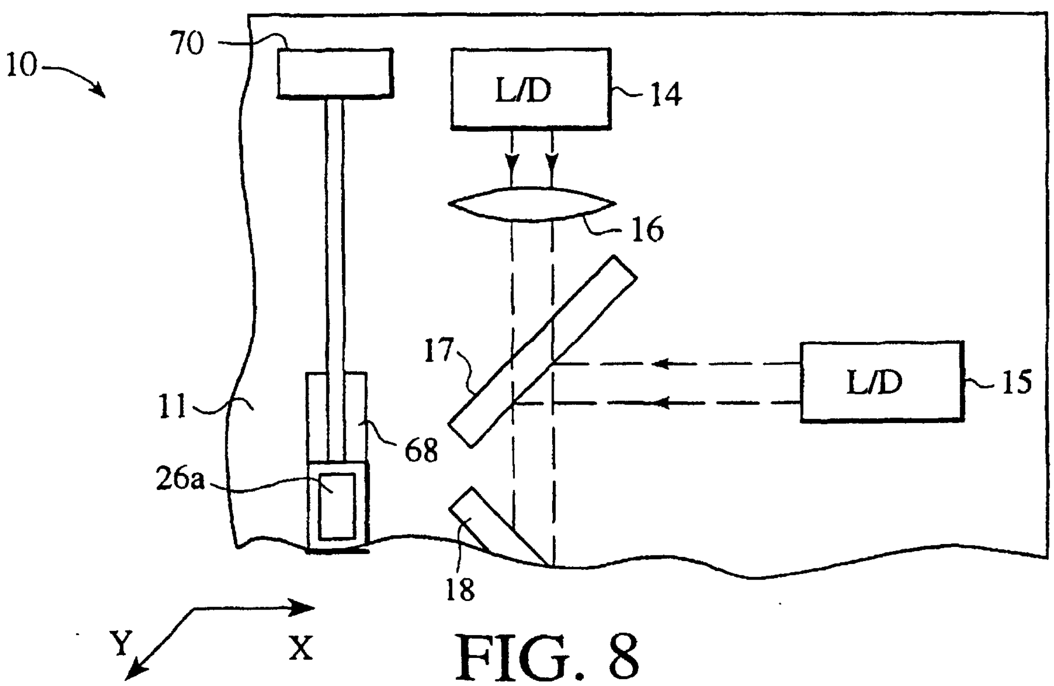
10
70
L/D
14
16
17
L/D
15
11
68
26a
18
Y
X

FIG. 8

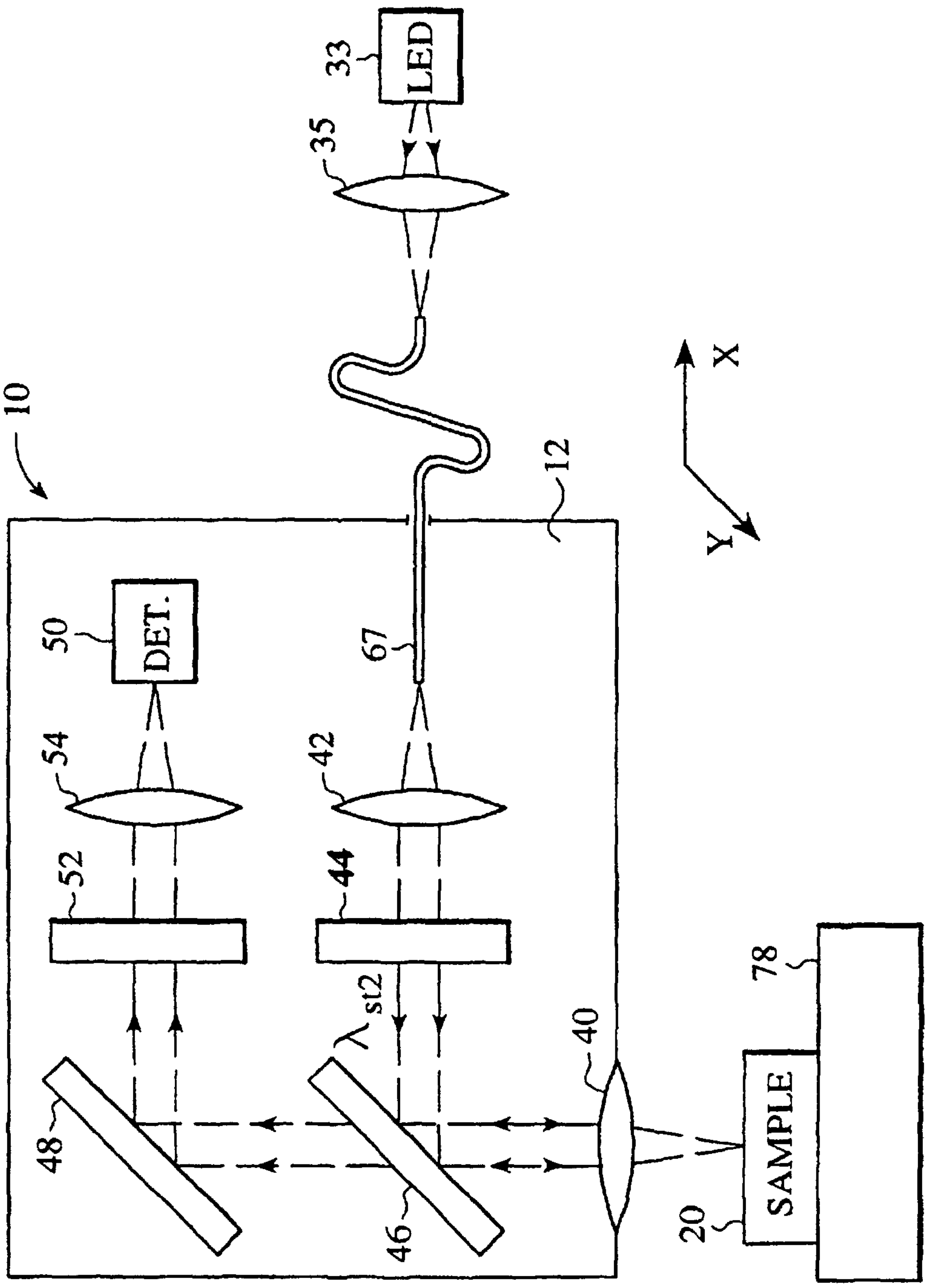
10
12
33
LED
35
67
50
DET.
54
42
52
44
λ_{st2}
40
48
46
20
SAMPLE
78
X
Y

FIG. 9

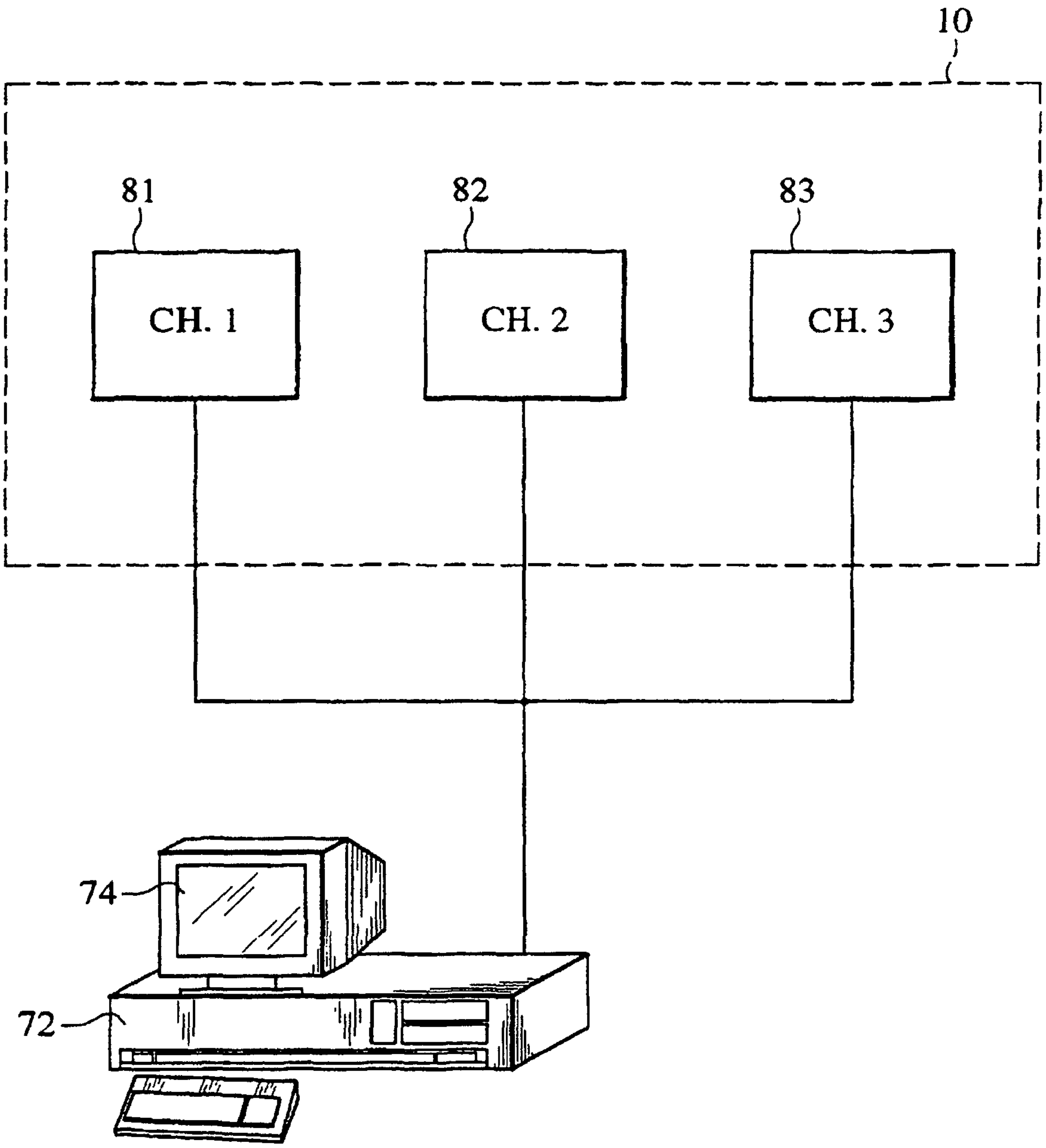

FIG. 10